

THE DYNAMICS OF BOWLING.<sup>1</sup>

FOLLOWING up their interesting volume on "Great Batsmen," the accomplished authors of "Great Bowlers and Fielders" have practically completed all that action photography can teach us regarding the methods of great cricketers. The present handsome volume with its 464 action photographs registers for all time the successive positions of the body in the act of bowling of some of the most celebrated bowlers of our day, and also certain very characteristic attitudes of a number of our best fielders. From the purely cricketing point of view the book must ever be of the most enthralling interest, not because it establishes any fundamentally new principle in the art of high-class bowling, but because it proves the wonderful variety of method by which different individual bowlers effect practically the same result. The movements of the body, arm, wrist, hand, and fingers are all coordinated to the one end of imparting to the ball a definite combination of translation and spin. It does not always happen that the bowler hits off the exact combination aimed at, but when he does the future progress of the ball through quiet air and off a good pitch is absolutely definite. There is no difficulty in understanding the dynamics of the "break"; the problem is simply that of a rotating sphere impinging obliquely on a rough surface, and is familiar to everyone who has handled a billiard cue with intelligence. The point of interest to the would-be bowler is how it is effected. This is discussed at considerable length in distinct parts of the book contributed by Messrs. F. R. Spofforth, B. J. T. Bosanquet, and R. O. Schwarz. The introductory chapter by the "Demon Bowler" (to whom the book is dedicated) is capital reading. It is, indeed, rather to be studied than read, and the same remark applies to Mr. Bosanquet's lucid and scientific discussion of the "off-breaking leg-break."

At the very outset it is obvious that no bowler can give to a cricket ball anything like the combined velocity and spin which can be so easily communicated to a golf ball, or even to a tennis ball. The comparative lightness of the latter enables the player to give it sufficient spin (with velocity) so as to call into action the differential air pressure, producing evident swerve. Tait, in his discussion of the golf-ball flight, showed that this swerving force (which acts at right angles to the plane containing the velocity and the axis of spin) may be taken as being proportional to the product of the translational and angular speeds. He estimated that it might attain a value equal to about four times the weight of the ball. In the case of the cricket ball it is doubtful if the deviating force due to air pressures acting on the progressing and rotating ball could ever become more than a small fraction of the weight. Then, as the rotation takes place in all over-hand delivery about an axis which makes at the most a small angle

with the horizontal, it is clear that there is very little chance of a cricket ball *beginning* its swerve to right or left for the same reason that a golf ball is sliced or pulled. How, then, is the swerve to be explained? The matter crops up at intervals throughout the book, and is discussed at some length by Mr. Spofforth; but with all due regard to his authority as one of the greatest bowlers of all time, it is difficult to accept his explanation as in every respect sound. He says that "a ball which has check spin (that is, under-spin) on it, loses it through friction against the air during its flight; at the moment this occurs the ball slips the cushion of air it has made, especially in between the seams. What leads me to



FIG. 1.—W. Rhodes at the beginning of his final swing. From "Great Bowlers and Fielders."

this belief is that it is almost impossible to swerve unless the seam of the ball is up and down. The check spin keeps the seam vertical until the air-resistance causes the spin to cease altogether. At this point, especially if the ball has an upward tendency and the earth's power of attraction is asserting itself, the swerve will be great. To swerve, the ball must have some spin on it, but not much. If it has great spin it will never lose it in time to swerve, and I maintain that at the actual time of swerving the ball has ceased to spin, or nearly so." Further on he says that he has "never seen any bowler swerve with the wind," that "a bowler swerves more while the ball is new," that he does

<sup>1</sup> "Great Bowlers and Fielders. Their Methods at a Glance. By G. W. Reldam and C. B. Fry. Pp. xv+547; illustrated. (Macmillan and Co., Ltd., 1906.) Price 21s. net.

not believe "anyone (bowling as is usual twenty-one yards or less) can get the swerve unless he over-pitches the ball." The facts seem to be that for right or left swerving it is essential to have a cross wind blowing, a long-pitched ball, and some initial spin with the seam vertical, but not too much of it. It is difficult to believe that the air's resistance can effectually destroy this spin, seeing that the air has apparently very little effect in cutting down the spin which ultimately produces the break. The very fact

the ball in addition to gravity according as there is under-spin or over-spin. Probably most bowlers have an average amount of spin which they put on the ball. This will give what the batsman regards as the normally pitched ball of that bowler. Suppose this normal spin to be over-spin. Then it is clear that if the bowler diminishes the over-spin or gives an under-spin the pitch (*other things being equal*) will be lengthened, but if the over-spin is increased the pitch will be shortened. Again,

if the normal spin is under-spin, a diminution of that will make the ball appear to drop shorter than the expected normal pitch. This is obviously one way of varying the pitch, and one which must be very deceptive to the batsman. This way of stating it might seem at first sight to be inconsistent with Spofforth's remark that "the vertical spin, unlike others, must have excessive check spin, which naturally impedes the flight of the ball from the start, and keeps it back from its true destination." It is difficult to see how check-spin can keep the ball back from the start. So far as motion through the air is concerned, there will be just as much retardation with the over-spin rotation as with the under-spin rotation. The word check-spin is, in fact, unfortunate, suggesting that it not only checks the progress of the ball after it strikes the ground—and that is the origin of the name—but also that it checks the ball as it moves through the air. In all probability the bowler, when putting on excessive check-spin, projects the ball with a somewhat smaller velocity than the motion of the arm would imply. The hand, in fact, must get ahead of the ball, as very clearly indicated in one of the photographs of R. O. Schwarz. With a pronounced under-spin a smaller velocity of projection is needed for a given length of pitch than when there is no spin, and the velocity of projection is less than what the motion of the arm would suggest. Hence the feeling of a retarded ball both to the bowler and the batsman. The direct effects of varying spins upon the trajectory as described above are true only when other conditions are the same, such as the velocity of projection and the height of the point of



FIG. 2.—J. Tunnicliffe securing a one-handed catch high up in the slips. From "Great Bowlers and Fielders."

that the ball is projected with a smaller spin to begin with will mean less effective frictional moment acting on the ball. Stokes, in fact, agreed with Tait that the frictional decay of spin in the case of a golf ball might be neglected to a first approximation, and we may assume the same for a cricket ball.

There is not the least doubt that spin with the seam vertical must produce "vertical swerve" to some extent, a downward or upward force acting on

projection; but in giving different amounts of spin to a ball it is evident that these other conditions cannot be always the same. The conditions of the problem are indeed difficult to state, and one great merit of Mr. Beldam's action photographs is that they throw so much light on the way in which the ball leaves the hand.

But the outstanding difficulty is to explain the right or left swerve, and the action photographs give little

help here. The main fact is that all swervers project the ball with the seam as nearly as possible in a vertical plane. In the grip the fingers do not touch the seam, although in some cases the thumb does. But evidently there is little purchase on the ball, which is projected with comparatively little spin. If cross wind is not absolutely essential it certainly greatly facilitates the swerve. With some bowlers the swerve is evident from the start; with others it begins to appear only during the latter half of the trajectory. The seam is really a roughened zone on which the air may be supposed to exert a greater frictional force than on the other parts of the ball, especially if the ball be new. With seam vertical and a cross wind blowing, certain definite dynamical effects will follow. One of these will be a tilting of the axis of rotation, a tilting which will, however, take place very slowly when the spin is excessive. This suggests the question, does the seam remain vertical throughout the flight of a swerving ball? The point might be settled by bowling a swerving ball against a blackened surface and finding which part of the ball first came in contact with the surface. That, however, is outside the purpose of the volume.

The questions of swerve and break have much scientific interest, but they cover only a part of the whole; and from a cricketer's point of view much might be said, not only as to the excellence of the pictures, but as to the instruction conveyed by them and by the accompanying letterpress. Mr. Beldam has aimed at getting a succession of positions of each bowler, from the beginning of the final stride before delivery to the follow through after the ball is delivered. In a few cases the series begins even sooner. Where so much is excellent and characteristic it is difficult to choose, but here we have reproduced two pictures which will show to what a high degree of perfection Mr. Beldam has carried his photographic art. The one represents W. Rhodes at the beginning of his final swing, and is chosen partly because of the perfection with which the grip of the ball is indicated. The other is taken from the last quarter of the book, which treats of fielders, and is a remarkably fine picture of J. Tunnicliffe securing a "wide, high up, right-handed catch in the slips." This is one of a series showing Tunnicliffe bringing off difficult catches in most extraordinary attitudes.

Like its predecessor, "Great Batsmen," this volume is a treasure-house of portraits of many of the most conspicuous cricketers of to-day. It is further beautified by a good coloured reproduction of the portrait of F. R. Spofforth painted by H. S. Tuke, A.R.A.

C. G. K.

#### THE POSITION OF AGATHOCLES DURING THE ECLIPSE OF B.C. 310 AUGUST 15.

ON B.C. 310 August 14 Agathocles left Syracuse by sea; at eight o'clock on the following morning he saw a total eclipse of the sun. His exact position is therefore of extreme interest to astronomers. Unfortunately, the course that Agathocles steered is not directly stated. The present paper is an attempt to piece together the various clues contained in the narratives.

We may first briefly glimpse at the way in which Airy handled this question (Phil. Trans., 1853, p. 188). It appears that on August 20, after a six days' voyage, Agathocles landed in Africa at a place that Airy identifies with Alhowareah. Supposing that he went direct, the distance travelled in six days would be 200 miles; if he went round Sicily the distance would be 330 miles. Airy therefore marks off on a map thirty-three miles in a southerly direction and fifty-

five miles in a northerly direction. He labels these positions as the "possible southern position" and "possible northern position," and he states in the text that the northern position is the more probable, partly because the distance is greater, and partly because the provision ships mentioned in the narrative probably came from Gela in the south.

To us, however, it appears totally incredible that Agathocles, after running from a superior enemy for twenty-four hours or thereabouts, should have been within fifty-five miles of his starting point. We will now proceed with our own attempt to reconstruct the situation.

The first point is that Agathocles started early in the morning, and to that extent had the more time in which to get to a distance from Syracuse. This is proved by an expression in the narrative of Diodorus:—"After six days and an equal number of nights, as dawn appeared" (*ἐξ δ' ἡμέρας καὶ τὰς ἴσας νύκτας αὐτῶν πλευσάντων, ὑποφαινούσης τῆς ἑως*). We have no wish to strain this expression to imply that he started at the exact instant of dawn on August 14. It clearly, however, implies that Agathocles was at sea for so great a part of August 14 as to render the phrase "six days and an equal number of nights" more exact than "five days and six nights."

Our second point is that Agathocles had a fair wind. We prove this as follows:—The Carthaginian fleet was blockading Syracuse, when some provision ships appeared in the neighbourhood. The Carthaginians went to attack the provision ships; Agathocles escaped from Syracuse; the Carthaginians left the provision ships and pursued Agathocles; the provision ships then entered Syracuse. It must be remembered that warships could be rowed, and that merchant vessels could only sail; and also that so late as the time of Nelson the power of beating to windward practically did not exist. The mere fact that the provision ships entered Syracuse therefore establishes the fact that the wind was favourable, both for the provision ships approaching Syracuse and for Agathocles flying from Syracuse; but other considerations will prove the same point. The Carthaginians, by leaving the provision ships when they had all but seized them (*πλησίον ἤδη τῶν φορηγῶν ὄντες*), clearly had no intention of letting Agathocles escape. Before going to attack the provision ships they probably argued that the occasion would find Agathocles utterly unprepared, and that by the time he had put his men and stores on board they would themselves be back again. Now a stern chase is proverbially a long chase (and, moreover, would have taken them out of sight of Syracuse), and the Carthaginians could not have entertained hopes of getting back in time unless the provision ships lay to windward of them. Even as it was, Agathocles was ready for his opportunity. His men, we are expressly told, had been on board for some days (*πληρώσας ἐξήκοντα ναῦς ἐπετῆρει καὶ ἰσχυρὸν οἰκείον πρὸς τὸν ἔκπλουον*), and he got to sea at exactly the right moment, that is to say, when the Carthaginians had all but reached the provision ships.

Agathocles therefore had a fair wind, and to that extent it is the more probable that he was at a considerable distance from Syracuse by the next morning.

Two minor points may here be noticed, though they are not essential to our main case. When the sixth day dawned Agathocles found himself in the vicinity of a Carthaginian fleet, not necessarily the same one. He rowed hard towards shore, and by virtue of a long start arrived first, although the Carthaginians were rapidly gaining on him, being more accustomed to rowing than the Syracusans (Justin). Possibly,